



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of : **Confirmation No. 9235**
Yoko MITARAI et al. : Attorney Docket No. 2003_1781
Serial No. 10/728,845 : Group Art Unit 1742
Filed December 8, 2003 : Examiner Kathleen A. McNelis
HIGH-MELTING SUPERALLOY AND METHOD OF PRODUCING THE SAME : **Mail Stop Amendment**

SUBMISSION OF VERIFIED ENGLISH TRANSLATION
OF PRIORITY APPLICATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

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Sir:

Referring to page 8, lines 5-6 of Applicants' Amendment filed November 9, 2006, Applicants are submitting herewith a verified English translation of their Japanese priority application. A certified copy of the priority application, together with a Claim of Priority, are also submitted concurrently herewith.

Respectfully submitted,

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HIGH-MELTING SUPERALLOY AND
METHOD OF PRODUCING THE SAME

DECLARATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir: 6-11-1, Minami-Aoyama
I, Toshio NISHIZAWA, of Minato-ku, Tokyo, Japan declare as follows:
(name of translator) (address of translator)

That I am well acquainted with the Japanese and English languages; and

That the attached translation is a true translation into English of Japanese application No. 025540, filed February 2, 1999.

I further declare that all statements made herein of my own knowledge are true, and that all statements on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signed this 9th day of November, 2006.

Toshio Nishizawa
(Signature of translator)

**PATENT OFFICE
JAPANESE GOVERNMENT**

This is to certify that the annexed is a true copy
of the following application as filed with this office.

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Patent Application Number: 025540/1999

Applicant(s): Japan as Represented by Director General
of National Research Institute for Metals

March 31, 2000

Takahiko KONDOU
Commissioner, Patent Office

(Translation)

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METHOD OF PRODUCING THE SAME
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[List of The Appended Documents]

[Name of The Document]	Specification	1 copy
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[Name of The Document]	Drawing	1 copy
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[Name of The Document]	Abstract	1 copy
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[Proof]	Necessary
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[Designation of document] Specification

[Title of the Invention] HIGH-MELTING SUPERALLOY AND
METHOD OF PRODUCING THE SAME

[Claims]

[Claim 1] A high-melting superalloy made of iridium or rhodium as a base comprising at least one metal selected from the group consisting of titanium, zirconium, hafnium, vanadium, niobium, and tantalum and at least nickel, wherein an fcc phase and an LI_2 phase are formed in a texture thereof.

[Claim 2] The high-melting superalloy according to claim 1, wherein a deposit having an LI_2 structure is conformity-deposited in the fcc phase of the matrix phase.

[Claim 3] The high-melting superalloy according to claim 1 or 2, wherein the volume % of the LI_2 phase is from 20 to 80 %.

[Claim 4] A method of producing the high-melting superalloy described in any of claims 1 to 3, which comprises adding nickel to one of an iridium-base superalloy made of iridium as a base containing from 2 to 22 atomic % of at least one metal selected from the metal group consisting of titanium, zirconium, hafnium, vanadium, niobium, and tantalum and a rhodium-base superalloy made of rhodium as a base containing from 2 to 22 atomic % of at least one metal selected from said metal group, or to metals or a combination of the alloys realizing one of said superalloys, followed by ingotting to produce a high-melting superalloy.

[Claim 5] The method of producing a high-melting superalloy according to claim 4, wherein the iridium-base superalloy or the rhodium-base superalloy exists in an amount of at least 5 mole % in terms of the superalloy, and nickel is added in an amount of at least 5 atomic %.

[Claim 6] A method of producing the high-melting superalloy described in any of claims 1 to 3, which comprises mixing one of an iridium-base superalloy made of iridium as a base containing from 2 to 22 atomic % of at least one metal selected from the metal group consisting of titanium, zirconium, hafnium, vanadium, niobium, and tantalum and a rhodium-base superalloy made of rhodium as a base containing from 2 to 22 atomic % of at least one metal selected from said metal group or metals or a combination of alloys realizing one of said superalloys, with a nickel-base alloy made of nickel as a base or metals or a combination of the alloys, followed by ingoting to produce a high-melting superalloy.

[Claim 7] The method of producing a high-melting superalloy according to claim 6, wherein the iridium-base superalloy, the rhodium-base superalloy, or the nickel-base alloy is mixed so that each alloy exists in an amount of at least 5 mole % in terms of each alloy.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention Belongs]

The present invention relates to a high-melting superalloy. More specifically, the invention relates to a new high-melting superalloy which is capable of improving the output and the heat efficiency of high-temperature instruments such as a gas turbine for electric power generation, a jet engine, a rocket engine, etc.

[0002]

[Prior Art and its Problems]

Turbine blades and turbine vanes used for high-temperature instruments such as a gas turbine for electric power generation, a jet engine, a rocket engine, etc., are used under high-temperature and high-stress conditions. Hitherto, for these turbine blades and turbine vanes, Ni-base superalloys having a high heat resistance and an excellent high-temperature strength have been used but the use temperature have become severe year by year. This is because the increase of a combustion gas temperature is the most effective correspondence to further increase the output and the heat efficiency of high-temperature instruments. Consequently, for the turbine blades and the turbine vanes, the improvement in the high-temperature strength has been desired, which means, in other words, that the improvement in the high-temperature strength of materials used for turbine blades and turbine vanes is indispensable. The durable temperature of Ni-base superalloys capable of having a

substantial strength is about 1,100°C. If a new material, which can be used at a temperature higher than the temperature and can be realized at a relatively low cost, can be developed, it is very useful for practical use.

[0003]

The present invention has been made in view of the circumstances as described above and its object is to provide a new high-melting superalloy which can further improve the output and the heat efficiency of high-temperature instruments, has the characteristics better than the related art Ni-base superalloys, and can be realized at a relatively low cost.

[0004]

[Means for Solving the Problems]

As a result of various investigations, the present inventors have discovered that by compounding or mixing an iridium-base alloy (melting point: 2,447°C) or a rhodium-base alloy (melting point: 1,960°C) having a high-melting point and a high strength at a high temperature and being excellent in the oxidation resistance, with nickel or a nickel-base alloy (density: 8.9 g/cm³ (cf., density of an iridium-base superalloy: 22.4 g/cm³, density of a rhodium-base superalloy: 12.44 g/cm³)), which is light-weight, is excellent in ductility, and is inexpensive as compared with the above-described superalloys, followed by ingoting, a

superalloy wherein both phases of an fcc phase and an LI_2 phase are formed in the texture, and a deposit having an LI_2 structure in the matrix phase having an fcc structure is conformity-deposited is obtained, and that the obtained superalloy is not only excellent in the high-temperature strength and the oxidation resistance but also relatively light-weight and also has a ductility, leading to accomplishment of the present invention.

[0005]

That is, the present invention is to provide a high-melting superalloy comprising at least one metal selected from the group consisting of titanium, zirconium, hafnium, vanadium, niobium, and tantalum and at least nickel, wherein an fcc phase and an LI_2 phase are formed in a texture thereof (Claim 1).

[0006]

The invention is to provide, as a preferred embodiment of the above high-melting superalloy that a deposit having an LI_2 structure is conformity-deposited in the fcc phase of the matrix phase (Claim 2) and that the volume % of the LI_2 phase is from 20 to 80 % (Claim 3).

Also, the invention provides a method of producing the high-melting superalloy described in any of claims 1 to 3, which comprises adding nickel to one of an iridium-base superalloy made of iridium as a base containing from 2 to 22

atomic % of at least one metal selected from the metal group consisting of titanium, zirconium, hafnium, vanadium, niobium, and tantalum and a rhodium-base superalloy made of rhodium as a base containing from 2 to 22 atomic % of at least one metal selected from the metal group, or to metals or a combination of the alloys realizing one of the superalloys, followed by ingoting to produce a high-melting superalloy (Claim 4).

[0007]

As a preferred embodiment for the invention of claim 4, the invention provides a method of producing a high-melting superalloy, wherein the iridium-base superalloy or the rhodium-base superalloy exists in an amount of at least 5 mole % in terms of the superalloy, and nickel is added in an amount of at least 5 atomic % (Claim 5).

Further, the invention provides a method of producing the high-melting superalloy described in any of claims 1 to 3, which comprises mixing one of an iridium-base superalloy made of iridium as a base containing from 2 to 22 atomic % of at least one metal selected from the metal group consisting of titanium, zirconium, hafnium, vanadium, niobium, and tantalum and a rhodium-base superalloy made of rhodium as a base containing from 2 to 22 atomic % of at least one metal selected from the metal group or metals or a combination of alloys realizing one of the superalloys, with a nickel-base

alloy made of nickel as a base or metals or a combination of the alloys, followed by ingoting to produce a high-melting superalloy (Claim 6).

[0008]

Still further, as a preferred embodiment for the invention of claim 6, the invention provides a method of producing a high-melting superalloy according to claim 6, wherein the iridium-base superalloy, the rhodium-base superalloy, or the nickel-base alloy is mixed so that each alloy exists in an amount of at least 5 mole % in terms of each alloy (Claim 7).

Then, the high-melting superalloy of the invention and the method of producing the same are described in detail.

[0009]

[Mode for Carrying Out the Invention]

The high-melting superalloy according to the invention is a ternary or higher alloy which comprises at least one metal selected from the group consisting of titanium, zirconium, hafnium, vanadium, niobium, and tantalum, and at least nickel wherein an fcc phase and an L1₂ phase are formed in a texture thereof.

[0010]

The high-melting superalloy of the invention is produced by adding nickel to, for example, one of an iridium-base superalloy made of iridium as a base containing

from 2 to 22 atomic % of at least one metal selected from the metal group consisting of titanium, zirconium, hafnium, vanadium, niobium, and tantalum and a rhodium-base superalloy made of rhodium as a base containing from 2 to 22 atomic % of at least one metal selected from the metal group, or to metals or a combination of the alloys realizing one of the superalloys, followed by ingoting.

[0011]

Also, the high-melting superalloy of the invention is produced by mixing one of an iridium-base superalloy made of iridium as a base containing from 2 to 22 atomic % of at least one metal selected from the metal group consisting of titanium, zirconium, hafnium, vanadium, niobium, and tantalum and a rhodium-base superalloy made of rhodium as a base containing from 2 to 22 atomic % of at least one metal selected from the metal group or metals or a combination of alloys realizing one of the superalloys, with a nickel-base alloy made of nickel as a base or metals or a combination of the alloys, followed by ingoting.

[0012]

The nickel-base alloy referred to in the latter production method includes from a binary alloy such as a nickel-aluminum (Ni-Al) alloy to a more than binary nickel-base superalloy which is presently used as heat resisting material for high-temperature instruments.

With respect to the ingoting in the production method, there is no particular restriction regarding the system. For example, there is illustrated a method including an arc-melting of the mixture and a homogenizing treatment for homogenizing the composition carried out thereafter as an example.

[0013]

The high-melting superalloys of this invention produced by these production methods each has both phase of the fcc phase and the LI_2 phase in the texture, the formation of the two phases ensure a sufficient strength. It is confirmed by analyzing the phase composition that nichel which is a component element added or blended partially replaces iridium or rhodium in this texture.

[0014]

Also, while it is considered that the composition ratio of the metal components on the superalloy is an important factor, a two-phase conformity texture wherein a deposit having an LI_2 structure, is conformity-deposited in the matrix phase having an fcc structure, is formed. In this case, the two-phase conformity texture means a texture wherein a row of adjacent crystal lattices is continued without being broken. When the two-phase conformity texture is formed, the strength is more increased than the superalloy simply made of two phases of the fcc phase and the LI_2 phase. This is considered to be

caused by that the conformity interface between the matrix phase and the deposit disturbs the transfer of the dislocation. Such a two-phase conformity texture is surely formed in the case where at least one of the iridium-base superalloy and the rhodium-base superalloy, and the nickel-base alloy are used as the raw materials in the above-described production method, and each alloy has a two-phase conformity texture having an fcc phase and an LI_2 phase.

[0015]

It is not always unnecessary that the fcc phase and the LI_2 phase each exists as one kind regarding the kind of constituting substances. Because the high-melting superalloy of the invention is the multi-component alloy as described above, it is possible that plural kinds of the fcc phases and LI_2 phases each having a different existing concentration exist together.

In the texture formed by both phases of the fcc phase and the LI_2 phase, it is preferred that an amount of the LI_2 phase is from 20 to 80% by volume. When the amount of the LI_2 phase is less than the lower limit, the strength is lowered. On the other hand, the LI_2 phase may exceeds the upper limit but the preparation of such a superalloy becomes considerably difficult.

[0016]

Also, in the case where the iridium-base superalloy or the rhodium-base superalloy, and nickel or the nickel-base alloy are used as the raw materials, the high-melting superalloy of the invention can independently show the characteristics of the iridium-base superalloy or the rhodium-base superalloy and nickel or the nickel alloy, in the above-described production method. That is, the high-melting superalloy of the invention shows all the high melting point, the high-temperature high strength, and the excellent oxidation resistance of the iridium-base superalloy or the rhodium-base superalloy and also the light-weight and the excellent ductility of nickel or the nickel-base alloy. Also, by the existence of nickel or the nickel-base alloy, the high-melting superalloy of this invention becomes relatively inexpensive.

[0017]

In this case, in order that the characteristics of these metals, alloys, and the superalloys are clearly observed, it is preferred that a mass ratio of the iridium-base superalloy or the rhodium-base superalloy is at least 5 mole % in terms of superalloy, and the content of nickel alone or the nickel-base alloy is at least 5 mole % in terms of metal or the alloy. When the contents of these superalloys and metal or the alloy are less than the lower limits, these characteristics of them are not always sufficiently obtained.

[0018]

The high-melting superalloy containing from 5 to 50 mole % the iridium-base superalloy or the rhodium-base superalloy of itself or in terms of them is light-weight and is considered to be effective as the rotary members of turbine blades, etc., and, on the other hand, when the content of the iridium-base superalloy or the rhodium-base superalloy is larger than the above-described content, as from 50 to 93%, the application of the high-melting superalloy of the invention to the members used at a higher temperature is expected to be useful.

[0019]

Then, the examples of the high-melting superalloy of the invention and the production method thereof are described.

[0020]

[Example]

Example 1:

An iridium-15 niobium (Ir-15Nb) alloy was compounded with nickel (Ni) and the mixture was arc-melted in a vacuum furnace under an argon atmosphere to produce four kinds of superalloys (ingots) of A, B, C, and D shown in Table 1 below.

[0021]

[Table 1]

Superalloy	Superalloy Composition (atomic %)		
	Ni	Nb	Ir
A	10	15	Balance

B	20	15	Balance
C	30	15	Balance
D	50	15	Balance

[0022]

From each ingot, a test piece having a height of 6 mm and a diameter of 3 mm was cut and subjected to an aging treatment in a vacuum furnace of 5×10^{-7} Torr at 1,300°C for one week. Also, the phase formed in each test piece was determined by an X-ray diffraction analysis (XRD) and an energy dispersion type X-ray analyzer (EDAX).

As a result, the superalloys A and B of Table 1 had the textures composed of only two phases of the fcc phase and the LI_2 phase. In particular, in the superalloy A, a two-phase conformity texture that the deposit having the LI_2 structure was conformity-deposited in the matrix phase having the fcc structure was formed. The fcc phase was made of Ir and the LI_2 phase was made of Ir_3Nb . Also, in each of these phases, Ni formed a solid solution with the phase. On the other hand, In the superalloys C and D, in addition to the above-described two phases, a δ phase ($(Ir, Ni)_{11}Nb_9$) belonging to a orthorhombic system was confirmed as a third phase. In addition, in each of the superalloys shown above, an amount of Ir_3Nb having the LI_2 structure was within the range of from 20 to 80% by volume.

[0023]

Figs. 1a to 1d each is an optical microphotograph of

each test piece.

In the superalloy A, a dendrite texture (Fig. 1a) was formed and in the superalloys B, C, and D, fine textures (Figs. 1b, 1c, and 1d) were formed. Also, it was confirmed that with the increase of the compounding amount of Ni, the texture became thicker and rougher.

Also, about the above-described test materials, a compression test (in the air, stress speed $3.0 \times 10^{-4}/s$) was carried out in the temperature range of from room temperature to $1,200^{\circ}C$. The results are shown in the graph of Fig. 2.

[0024]

As is clear from the graph of Fig. 2, the compression strength of superalloy A was about 2 times that of Ir-15Nb at room temperature and was almost the same as that of Ir-15Nb at $1,200^{\circ}C$. The compression strengths of superalloys B, C, and D were lower than the compression strength of Ir-15Nb at both room temperature and $1,200^{\circ}C$. However, the compression strengths of each of the above superalloys are higher than that of an Ni-base superalloy used for high-temperature instruments.

[0025]

Also, in each of the superalloys, the ductility is improved by the addition of Ni. Particularly, in superalloy B, the ductility is about 13%, which is far higher than that of Ir-15Nb. Also, it is admitted that the utility of the

superalloys is higher than the Ir-15Nb alloy. Furthermore, because a part of Ir is replaced with Ni, the Ir amount of the superalloys can be reduced, which lowers the cost of the alloys. Thus, in the point, the high utility of the superalloys is also confirmed.

Example 2:

As the iridium-base superalloy, an iridium-20 niobium (Ir-20Nb) alloy and an iridium-20 tantalum (Ir-20Ta) alloy were selected and, as the nickel-base alloy, a nickel-16.8 aluminum (Ni-16.8Al) alloy was selected. The mol fractions of the iridium-base superalloy and the nickel-base alloy were selected to be Ir-base superalloy : Ni-base alloy = 25 : 75 (group A), 50 : 50 (group B), and 75 : 25 (group C), sum total 6 kinds of the quaternary alloys of the compositions shown in Table 2 below were prepared by arc-melting in an argon atmosphere.

[0026]

[Table 2]

	Superalloy Composition (atomic %)	
Group A	Ir-5Nb-62.4Ni-12.6Al	Ir-3.75Ta-62.4Ni-12.6Al
Group B	Ir-10Nb-41.6Ni-8.4Al	Ir-7.5Ta-41.6Ni-8.4Al
Group C	Ir-15Nb-20.8Ni-4.2Al	Ir-11.25Ta-20.8Ni-4.2Al

[0027]

About these six kinds of the quaternary alloys, the phase determination and the texture observation as in Example 1 were carried out.

As a result, in the 4 kinds of the superalloys of group

A and group C, the two-phase conformity textures composed of the fcc phase ((Ir, Ni)) and two kinds of LI₂ phases ((Ni, Ir)₃ (Al, Ir) and (Ir, Ni)₃ (Nb, Al), or (Ni, Ir)₃ (Ni, Ta) and (Ir, Ni)₃ (Ta, Al)) were formed. On the other hand, in the two kinds of the superalloys of group B, the two-phase conformity textures by the fcc phase and two kinds of the LI₂ phases same as those of the superalloys of group A and group C were formed but in the cases, B2 phase ((Ir, Ni) (Al, Nb) or (Ir, Ni) (Al, Ta)) was additionally observed.

[0028]

In addition, in the above-described composition formulae, for example, (Ni, Ir)₃ (Al, Nb) means Ni₃Al containing Ir and Nb, wherein a part of Ni is replaced with Ir and a part of Al is replaced with Nb. Other composition formulae also employ the same expression system as above.

Figs. 3a, 3b, and 3c are the secondary electron images showing the textures of Ir-Nb-Ni-Al quaternary alloys belonging to group A, group B, and group C, respectively.

[0029]

In the superalloy A, the fcc phase and the first LI₂ phase of Ni₃Al containing Ir and Nb were observed. In the superalloys B and C, larger LI₂ phases were deposited. The B2 phase was observed in the superalloy B only as described above. In three superalloys A to C, together with the first LI₂ phase of Ni₃Al containing Ir and Nb, a small second LI₂ phase

of Ir₃Nb containing Ni and Al was found in the fcc matrix phase.
[0030]

Then, the alloys prepared were subjected to an aging treatment in vacuo at 1,300°C and 1,400°C for one week and the textures were observed again.

In each superalloy subjected to the aging treatment of 1,300°C, two kinds of small second LI₂ phases were deposited from the fcc matrix phase. As the result of the phase analysis of the superalloys B and C, it was confirmed that the second LI₂ phase contained larger amount of Ni than the first LI₂ phase. In the superalloy A, 23 atomic % Ir was contained in the first LI₂ phase. The Ir amount in the matrix phase increased with the increase of the Ir amount of the superalloy. On the other hand, the Nb amount in the matrix phase is almost the level of 5 atomic %. After the aging treatment at 1,400°C, in addition to a larger first LI₂ phase, a large amount of second LI₂ phases each having a different form and size were formed in the fcc phase. Also, in the superalloy B, the B2 phase was vanished. Thus, it is considered that the melting point of the B2 phase in the superalloy B is 1,400°C. Also, in each of the superalloys, the amount of the LI₂ phase was within the range of from 20 to 80% by volume ratio.

[0031]

The above-described texture observation results were the same as those about the Ir-Ta-Ni-Al quaternary alloy.

Then, each of the following six kinds of the quaternary alloys was heated to 1,400°C for one week, and the compression strength of each of them at 1,200°C was measured. The results are shown as the correlation diagrams of Fig. 4 and Fig. 5.

In theses Fig. 4 and Fig 5, for comparison, the strengths of an Ni-base superalloy (Marm 247) and the iridium-base superalloys of Ir-15Nb and Ir-20Nb are shown together.

[0032]

Each of the quaternary alloys shows the high compression resistance as compared with an Ni-base superalloy applied to high-temperature instruments. On the other hand, the compression strengths of these quaternary alloys are lower than that of Ir-Nb. However, the ductility of each alloy is, by mixing of the nickel-base alloy, 18% at the lowest and is improved as 89% is obtained at the highest. Thus, it is admitted that the utility of the alloys is higher than Ir-15Nb.

[0033]

Also, from Fig. 4, it is confirmed that the compression strength of the quaternary alloy is more improved with the increase of the addition amount of Nb or Ta which is the addition component of the indium-base superalloy.

Example 3:

Four samples having the compositions of $Rh_{85-x}Nb_{15}Ni_x$ ($x = 10, 20, 30, \text{ and } 50$) were prepared by arc-melting and from

each ingot, a test piece of a height of 6 mm and a diameter of 3 mm was cut. The test piece was subjected to an aging treatment in vacuo ($< 10^{-5}$ Pa) at 1,200°C for 100 hours. Also, a compression test (in the air, stress speed 3.0×10^{-4} s $^{-1}$) was carried out at a temperature of from 20 to 1,200°C. Each test piece was heated to the test temperature for from 12 to 20 minutes in a furnace so that a uniform temperature distribution was obtained during the test and kept at the temperature for 5 minutes before the initiation of loading. The compression strength was calculated from the change of the height of each test piece before and after the test.

[0034]

Also, the texture of each superalloy was observed by a scanning electron microscope (SEM) and a transmission electron microscope (TEM). The test piece observed by the scanning electron microscope was electron-polished with an ethyl alcohol solution of 5% HCl. The crystal structures and the phase compositions of the superalloys after the heat treatment were determined by an X-ray diffraction analysis (XRD) and an energy dispersion type X-ray analyzer (EDAX).

[0035]

Each of the superalloys of $Rh_{85-x}Nb_{15}Ni_x$ of $x \leq 30$ had the texture composed of only two phases of the fcc phase and the LI_2 phase of Rh_3Nb containing Ni. Particularly, in the $Rh_{75}Nb_{15}Ni_{10}$ superalloy of $x = 10$, a two-phase conformity

texture that a deposit having the LI_2 structure was conformity-deposited in the matrix phase having the fcc structure was formed. On the other hand, in the $Rh_{35}Nb_{15}Ni_{50}$ superalloy of $x = 50$, a γ'' phase $((Ni, Rh)_3Nb)$ belonging to an orthorhombic system was confirmed. The contents of Ni contained in Rh_3Nb were from 4.8 atomic % of $Rh_{75}Nb_{15}Ni_{10}$ ($x = 10$) to 19.6 atomic % of $Rh_{35}Nb_{15}Ni_{50}$ ($x = 50$). Also, in each superalloy, an amount of the LI_2 phase was within the range of from 20 to 80% by volume.

[0036]

Fig. 6 is the microphotographs of the superalloys heat-treated for 100 hours at $1,200^\circ C$.

Figs. 6a to 6d correspond to the compositions of $Rh_{85-x}Nb_{15}Ni_x$ ($x = 10, 20, 30$, and 50), respectively, and, in each of the superalloys, a dendrite texture is formed. From the comparison of Figs. 6a to 6d, it is confirmed that with increase of the compounding amount of Ni, the texture becomes coarser as in Example 1.

[0037]

Fig. 7 is a correlation diagram showing the compression strength and the ductility of the $Rh_{85-x}Nb_{15}Ni_x$ superalloys in the relation of the content of nickel. In Fig. 7, the data of the Rh-15 atomic % Nb alloy are shown together for comparison.

At room temperature, each of the superalloys with Ni

added shows a high compression strength as compared with the Rh-Nb two-phase alloy. At 1,200°C, the compression strength of $\text{Rh}_{75}\text{Nb}_{15}\text{Ni}_{10}$ ($x = 10$) is 473 MPa, which is higher than the compression strength of the Rh-Nb two-phase alloy but the compression strength lowers with the increase of the content of Ni. However, the compression strength of each of the superalloys is higher than that of Ni-base superalloys which have hitherto been applied to high-temperature instruments.

[0038]

About the ductility at room temperature, the superalloys with Ni added are equal to that of the Rh-Nb two-phase alloy in the composition on $\text{Rh}_{55}\text{Nb}_{15}\text{Ni}_{30}$ ($x = 30$) but the superalloys having other compositions show lower values. However, the ductility of the superalloys is 11% ($\text{Rh}_{75}\text{Nb}_{15}\text{Ni}_{10}$ ($x = 10$)) at the lowest and have the room-temperature ductility higher than those of the In-base superalloys shown in Example 1.

Example 4:

By following the same procedure as Example 2 except that rhodium was used as the component of constituting the superalloys in place of iridium, superalloys were prepared. The compression strength and the ductility of each superalloy were measured together with the determination of each phase and the observation of each texture. Each of the superalloys obtained shows a high compression strength and an improved

ductility almost the same as those of Example 2 using iridium, as compared with the Ni-base superalloys which have hitherto been used for high-temperature instruments.

[0039]

As a matter of course, the invention is not limited to the above-described examples. That is, about the compositions, the compounding ratios, the preparation methods, etc., of the superalloys, various modifications are possible.

[0040]

[Effect of the Invention]

As described above in detail, according to the present invention, new high-melting superalloys which have the characteristics better than Ni-base superalloys in related art and can be realized at a relatively low cost are provided. Also, by the invention, the more improvements in the output and the heat efficiency of high-temperature instruments can be realized.

[Brief Description of the Drawings]

Figs. 1a, 1b, 1c, and 1d each is an optical microphotograph showing the texture of each sample in Example 1;

Fig. 2 is a bar graph comparing the compression strength and the ductile of each sample in Example 1 with those of Ir-15Nb;

Figs. 3a, 3b, and 3c each is a secondary electron image photograph showing the texture of the In-Nb-Ni-Al quaternary alloy in Example 2;

Fig. 4 is a correlation diagram showing the correlation of the mol fraction of an iridium-base superalloy and the compression strength of the superalloy prepared in Example 2;

Fig. 5 is a correlation diagram showing the correlation of the addition amount of niobium or tantalum in an iridium-base superalloy and the compression strength of the superalloy prepared in Example 2;

Figs. 6a, 6b, 6c, and 6d each is a microphotograph showing the texture of each sample in Example 3;

Fig. 7 is a correlation diagram showing the correlation of the content of nickel in the superalloys prepared in Example 3 to the compression strength and ductile thereof.

[Designation of Document] Abstract

[Abstract]

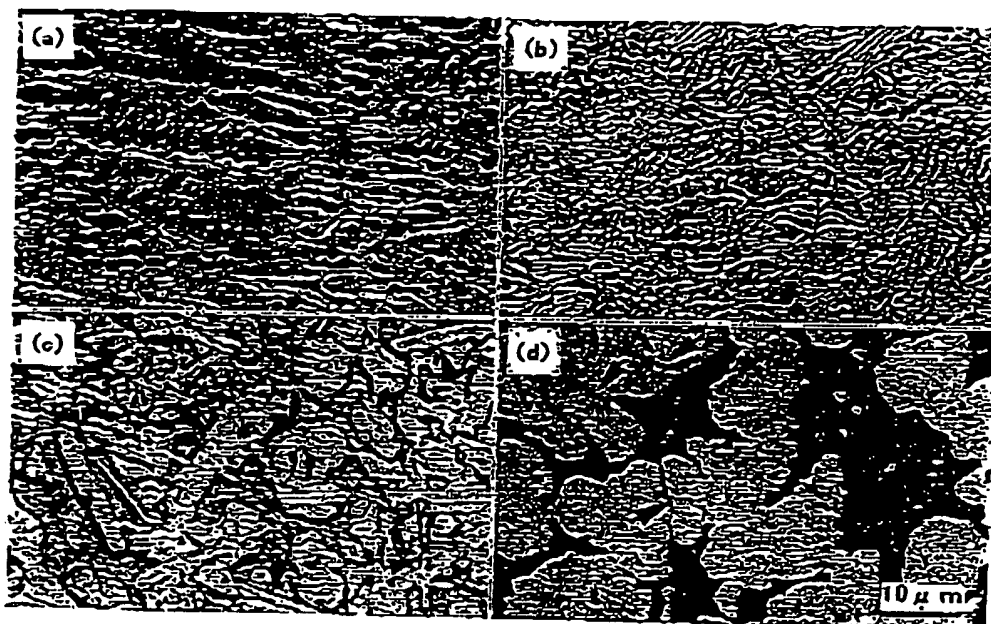
[Problem] To provide a new high melting superalloy which has the characteristics better than the Ni-base superalloy and can be realized at a relatively low cost.

[Means for Resolution] The new iridium- or rhodium-based high-melting superalloy comprises at least one metal selected from the group consisting of titanium, zirconium, hafnium, vanadium, niobium, and tantalum and at least nickel wherein an fcc phase and an L1₂ phase are formed in the texture thereof.

[Selected Drawing] Figure 1

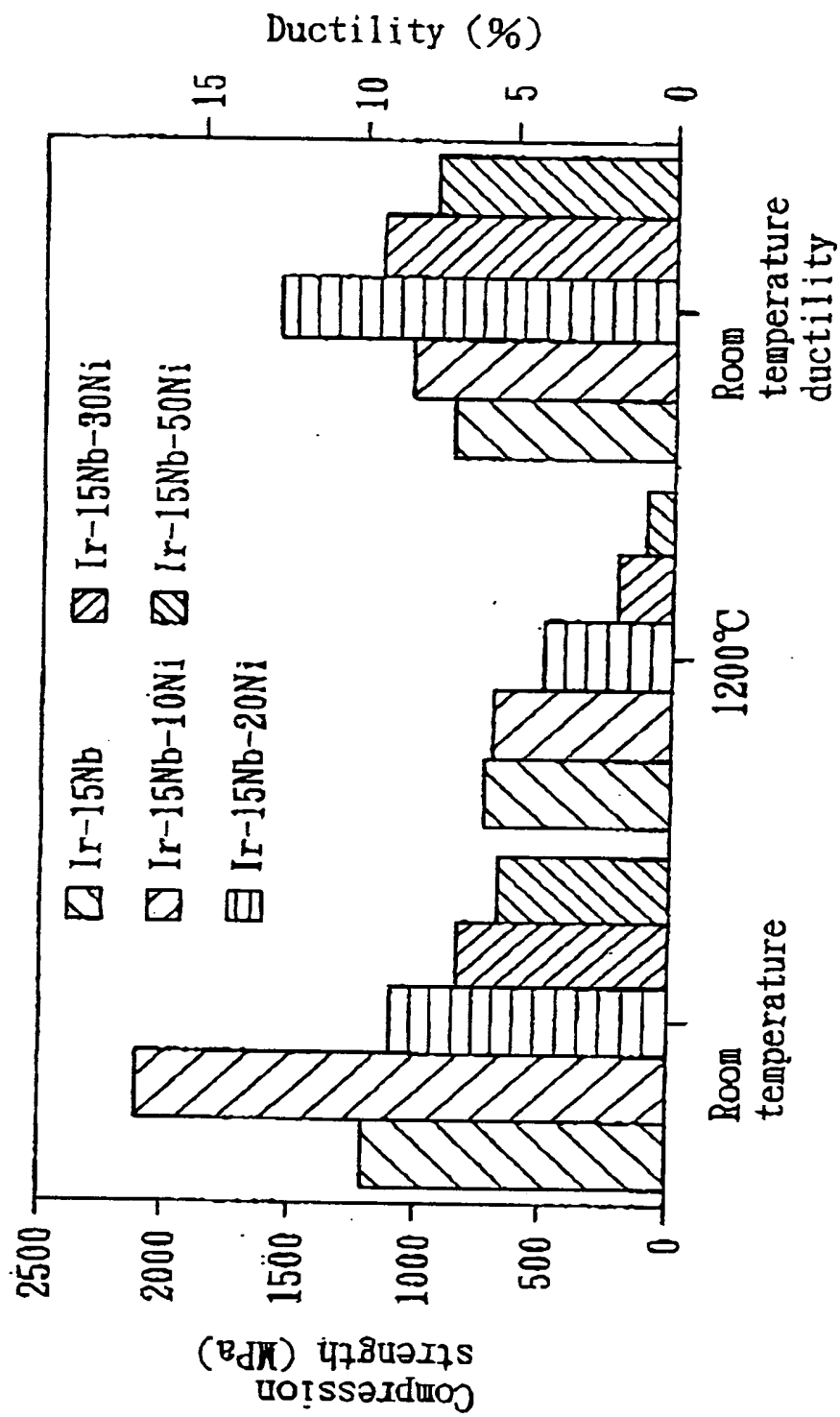
[NAME OF THE DOCUMENT] FIGURE

[Fig. 1]



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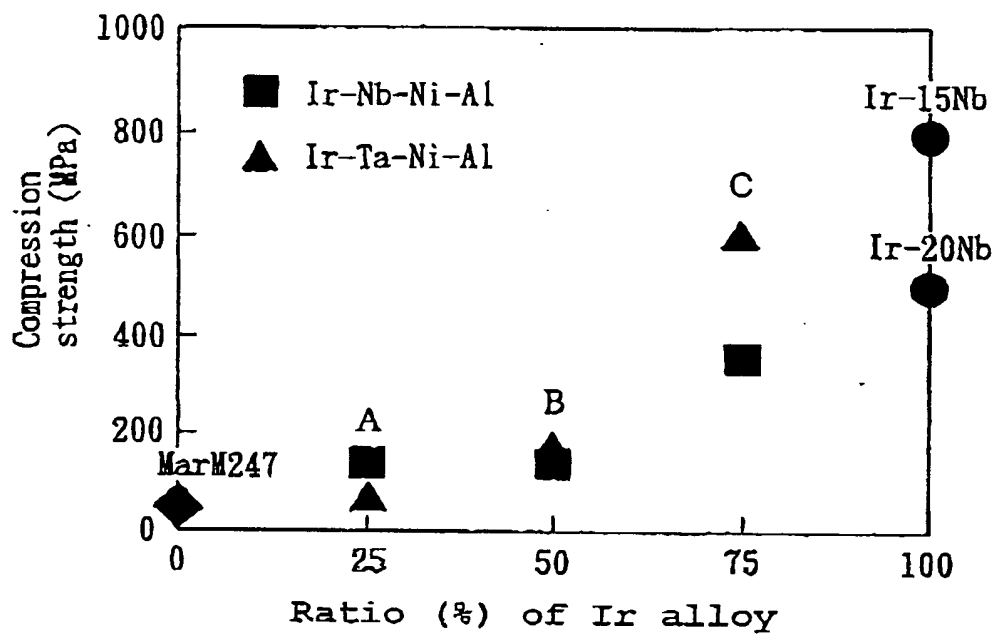
[Fig. 2]



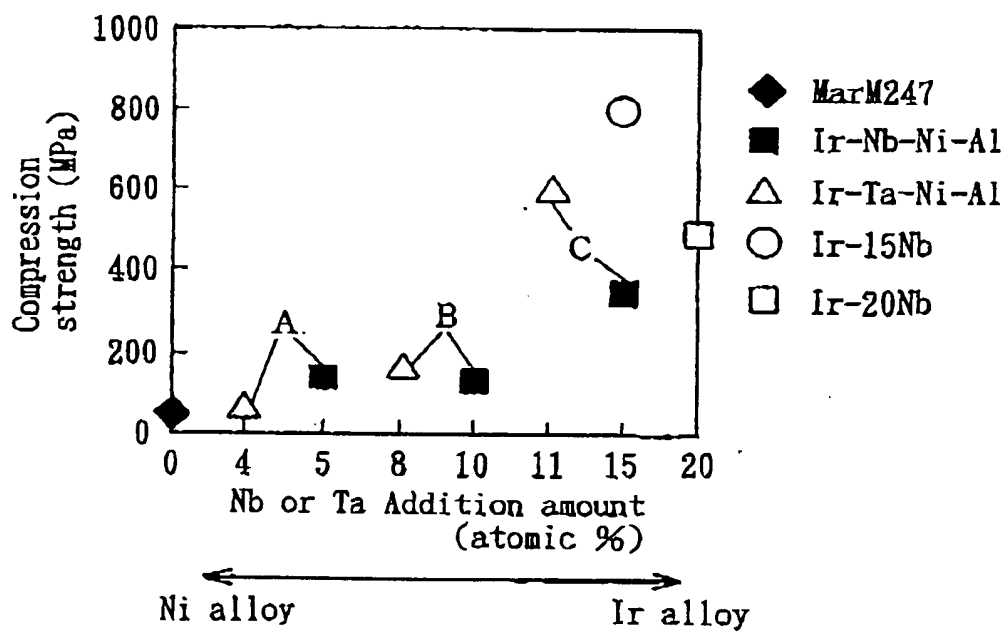
[Fig. 3]



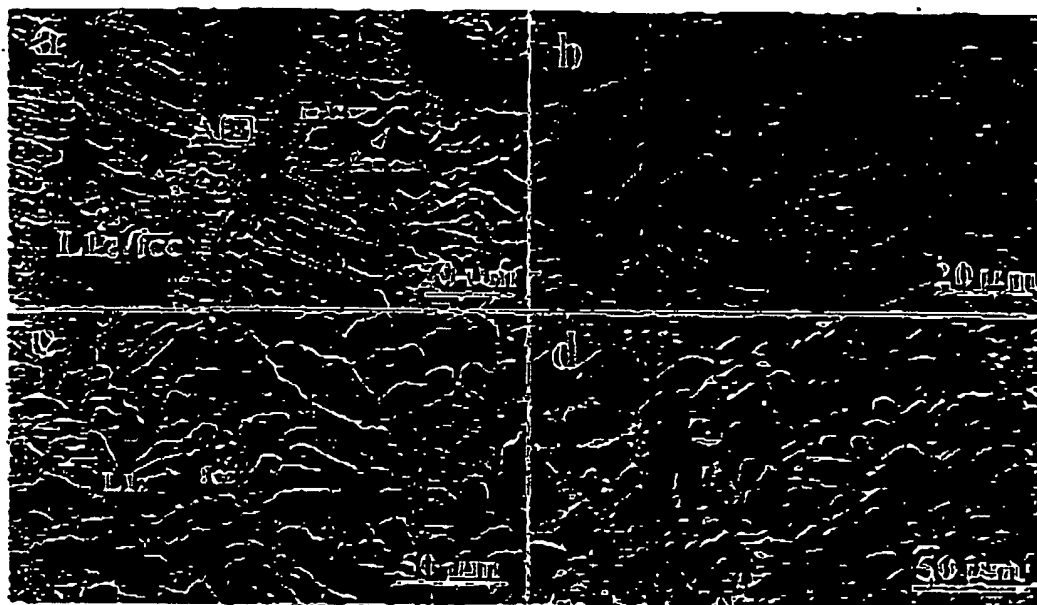
[Fig. 4]



[Fig. 5]



[Fig. 6]



[Fig. 7]

